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Variation within *Asterolasia asteriscophora sensu lato* (Rutaceae: Boronieae) and the recognition of new taxa in eastern Australia

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Abstract

Asterolasia asteriscophora (F.Muell.) Druce *sensu lato* exhibits considerable variation in a range of floral and vegetative characters. Phenetic analysis of 14 morphological characters for 17 populations of *A. asteriscophora sensu lato* has elucidated three new taxa: *A. asteriscophora* subsp. *albiflora* B.J.Mole, *A. rupestris* B.J.Mole and *A. rupestris* subsp. *recurva* B.J.Mole, and supports the recognition of *A. buckinghamii* (Blakely) Blakely and *A. buxifolia* Benth. as distinct species. Isozyme electrophoresis and subsequent interpretation proved problematic, however allele frequency data for a limited number of enzyme systems were broadly congruent with morphometric analyses. A key and detailed taxonomic descriptions are provided.

Introduction

Asterolasia asteriscophora (F.Muell.) Druce is a variable taxon of eastern Australia currently suspected to contain several infraspecific taxa (Wilson 1970, 1980, *ined.*; Duretto 1999). The species was first described by Ferdinand von Mueller (1855) as *Phebalium asteriscophorum* F.Muell., from material he collected in 1852 at Mt Disappointment, north of Melbourne, Victoria. Bentham (1863) placed it in *Asterolasia* F.Muell. as *A. muelleri* Benth. Druce (1917) noted that Bentham had not used the correct epithet when transferring the species to *Asterolasia* and so made the correct combination.

As currently circumscribed (see Porteners 1991; Duretto 1999), *A. asteriscophora* is a slender, erect, many-branched shrub, 1–2 m in height. Leaves, stems and the abaxial surface of the petals are covered with an indumentum of stalked, multiangular, stellate trichomes. The leaves are highly variable in shape and size, spathulate to obovate, oblong-cuneate or elliptic, 3–34 mm long, and 2–12 mm wide. A form with obcordate leaves is known from Mt Kaputar National Park in New South Wales. The inflorescences are terminal or axillary, solitary or in few flowered umbels, with the terminal flower reaching anthesis first, followed by the lateral flowers. Petals are usually yellow though plants from the Emerald area (Vic.) have white petals. The range of the species' extends from the Macedon Ranges in Victoria to the Torrington district in northern New South Wales (Fig. 1). Although the species is widespread, populations are generally small and disjunct.

The form of *A. asteriscophora* with white petals noted by Wilson (*ined.*) and Duretto (1999) from Emerald, Victoria, has been described as *Eriostemon spathulifolius* Gand. (Gandoger 1913), but has not been formally recognised in recent flora treatments (Willis 1973; Duretto 1999). This form is located within a residential zone and is now only known from three localities in the Emerald-Avonsleigh district, c. 45km ESE of Melbourne, Victoria. Formal taxonomic recognition of this form would have immediate conservation implications as the populations are threatened directly and indirectly by residential development.

Wilson (1998) noted that in the *Flora of New South Wales* (Porteners 1991) *A. buxifolia* Benth. was not accounted for. This is also the case for *A. buckinghamii* (Blakely) Blakely, although this was not noted by Wilson (1998). Wilson (1970), however, listed *A. buckinghamii* as an accepted taxon. In order to resolve taxonomic problems in the *A. asteriscophora* species group, specimens were subjected to a phenetic analysis. It was

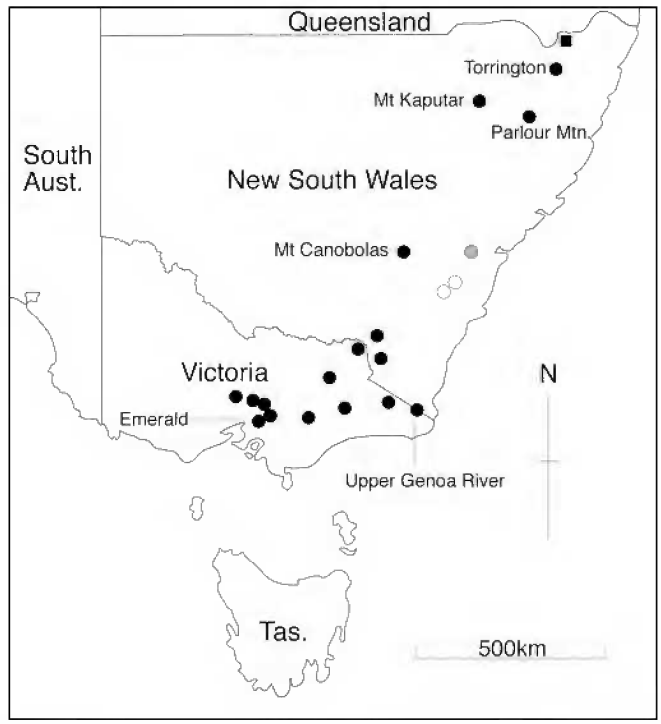

Figure 1. Known distribution of *Asterolasia asteriscophora sensu lato* (black circles), *A. buxifolia* (shaded circle), and *A buckinghamii* (open circles). All populations were sampled in this study except for Mt Canobolas, Upper Genoa River, and *A. buxifolia*, which are represented by herbarium specimens. The black square represents the single population of *A. correifolia* sampled for isozyme analysis. Under the new classification proposed here, populations from Mt Kaputar and Mt Canobalas are *A. rupestris* subsp. *rupestris*; those from Parlour mountain are *A. rupestris* subsp. *recurva*; those from Emerald are *A. asteriscophora* subsp *albiflora*; other populations from Victoria and NSW are *A. asteriscophora* subsp *asteriscophora*.

evident prior to analyses that *A. buxifolia* was distinct based on its glabrous ovaries, (character 13), however, as this taxon had apparently been treated as conspecific with *A. asteriscophora*, it was included in analysis 1.

Methods and Materials

POPULATION SAMPLING

Seventeen populations representing the known geographic range of *A. asteriscophora sensu lato* (Fig. 1) were sampled between November 1998 and January 1999. For the morphometric analysis, five individuals were sampled from each population. The exception was the population at Pine Mountain which consisted of only six individuals, from which only a small sample from one individual was taken. Herbarium specimens from BRI, CANB, MEL, MELU, NE, NSW, and K were used to supplement field collections for areas not sampled during field work. Herbarium acronyms follow Holmgren *et al.* (1990).

A subset of 12 populations was sampled for isozyme analysis. For each population, 3–12 leaves were collected from 15 individuals. Fifteen individuals of a closely related but morphologically distinct species, *A. correifolia* (A.Juss.) Benth., were also sampled for comparison. Three voucher specimens were collected for each population.

MORPHOLOGICAL CHARACTERS

One hundred and sixteen specimens (Appendix 1) were scored for 14 morphological characters (Table 1) reflecting the variation in leaf shape, leaf size, density and type of indumentum, petiole length, petal colour, peduncle and pedicel length, and number of flowers per inflorescence. All continuous characters were scored as an average of measurements from five organs (where five organs were available). Most characters are self explanatory, but a few require further clarification.

The prophylls of *A. asteriscophora sensu lato* are leaf-like and may be confused with leaves. They can be distinguished on the basis of their position. Prophylls subtend the pedicels, and are similar in shape and size to one another but consistently different from leaves subtending an inflorescence or axillary shoot. Leaves subtending an inflorescence or axillary shoot were interpreted as true leaves.

Leaf size is highly variable within populations and appears to be related to the age of the plant. Relatively young, vigorous plants tend to have larger leaves than more mature plants. Only mature specimens were used in this analysis.

Ratio characters, leaf length:leaf width (character 2), leaf length:distance to widest point from leaf base (character 3), and petal length:petal width (character 10), were used to quantify the shape of leaves and petals respectively. Since the shape of leaves and petals was consistent on any given individual, length and width measurements were considered to be measuring the same character (leaf size). Therefore width measurements for both leaves and petals were removed prior to analysis.

Table 1. Characters scored for morphometric analyses.

Characters were used in both analyses unless indicated

Continuous characters

1. Leaf length (along midvein) (mm)
2. Leaf length : leaf width
3. Leaf length : distance to widest point from leaf base (mm)
4. Length of petiole (mm)
5. Trichome density (per mm square) on adaxial leaf surface
6. Average number of flowers per unit inflorescence
7. Length of peduncle at anthesis (mm)
8. Length of pedicel at anthesis (mm)
9. Length of petal (mm)
10. Petal length : petal width

Binary characters

11. Leaf margins recurved/not recurved 0/1
12. Indumentum on abaxial petal surface multiangular/globular stellate 0/1 (analysis 1 only)
13. Ovary glabrous/stellate indumentum 0/1 (analysis 1 only)

Multistate characters

14. Petal colour white(0)/pale lemon(1)/yellow (2)

Trichome density of the adaxial surfaces of leaves (character 5) was calculated using transparent grid paper (1 mm^2). The grid was placed over a leaf surface midway along the leaf, avoiding the midrib, and the number of trichomes in five separate grids were counted, and the average recorded for each leaf. The number recorded for each specimen is the average of five leaves.

Peduncle length (character 7) and pedicel length (character 8) showed considerable variation within a single individual but meaningful comparisons could be made by measuring only those subtending flowers at anthesis. Generally, pedicel length was greater at anthesis than in bud and greater still in fruit. Some specimens had solitary flowers while others had umbels of three or more flowers. When specimens had umbels of three or more flowers, the pedicel of the central flower was measured for consistency.

SCANNING ELECTRON MICROSCOPY

Adaxial and abaxial leaf surfaces of specimens were examined to ascertain the structure of trichomes present, and to illustrate variation in trichome density. Leaves stored in 70 % ethanol were air dried and mounted on stubs with the aid of carbon adhesive discs and conductive silver paint. Samples were coated with gold using an Edwards Sputter Coater S150 B and examined and photographed using a Phillips XL 30 Field Emission Scanning Electron Microscope.

MULTIVARIATE PATTERN ANALYSIS

Multivariate pattern analyses were completed using the computer package PATN (Belbin 1987). A distance matrix was constructed using the Manhattan metric distance measure. The Manhattan metric depends on the range of all characters used for its scaling factor (Sneath and Sokal 1973), therefore, all data were range standardised prior to each analysis to ensure all characters were of equal weight (Sneath & Sokal 1973; Milligan & Cooper 1988). Two sets of analyses were performed, the first included all specimens, while the second excluded specimens of *A. buxifolia*. Both sets of analyses included an Unweighted Pair Group Method of Averaging (UPGMA) hierarchical classification to identify discrete clusters of individuals and a Non Metric Multidimensional Scaling (NMDS) ordination to identify continuous variation and clusters of individuals.

Co-phenetic correlation coefficients for dendrograms were calculated using a Spearman Rank correlation coefficient in the computer program SPSS (Norusis 1990). Cramer values, which give a measure of the discriminating powers of characters for each group identified in a classification (Belbin 1987), were also calculated. Cramer values have a scale of 0–1, with a higher value indicating a higher discriminating power for the relevant character.

Twenty different starting configurations were used in each NMDS analysis to ensure that the ordination which best fits the data was obtained. This is identified by the run with the lowest stress value, which is an indication of the degree of correlation of the distances between individuals in the ordination and distances in the original distance matrix. There was little difference in stress values for all twenty runs, indicating global minima were obtained (Kruskal & Wish 1973). Three-dimensional and two-dimensional analyses were performed. Because three dimensional ordinations provided only marginally greater information on groups than two-dimensional ordinations, only two-dimensional ordinations are presented here.

A Minimum Spanning Tree (MST) was also calculated. A MST connects all individuals with single linkages so that the shortest possible tree is constructed with no closed loops. It gives a more accurate portrayal of inter-entity distance than an ordination, which loses some of this information, particularly when the number of dimensions used is low (Belbin 1987).

ISOZYMES

One hundred and ninety five individuals from 13 populations (15 individuals per population) were assayed for isozyme polymorphisms. Small pieces of leaf were ground in the grinding buffer of Warburton *et al.* (2000) in Eppendorf tubes using a hand held electric drill.

Protein electrophoresis was carried out using the Titan III cellulose acetate system (Helena Laboratories) as described by Coates (1988). Thirteen different enzyme systems often found to be polymorphic in plants were tested using three continuous running

buffers: (1) TEM, (2) CM (Warburton *et al.* 2000) and TG (Hebert & Beaton 1989). Only four enzymes run in TG running buffer gave reliable banding patterns for the majority of samples: aspartate aminotransferase (AAT, EC 2.6.1.1), fumarate (FUM, EC 4.2.1.2), glucose-6-phosphate isomerase (GPI, EC 5.3.1.9) and phosphoglucomutase (PGM, EC 5.4.2.2). After electrophoresis for 20–30 min, depending on the enzyme, gels were stained using an agar overlay of 6 ml of 1% agar at 45°C added to the appropriate stains, described by Hebert and Beaton (1989) but scaled down to a volume of 1.2 ml.

Each zone of activity on gels was assumed to represent a single locus. Alleles were numbered according to their electrophoretic mobility and recorded in a table for further analysis.

ANALYSIS OF ISOZYME DATA

The BIOSYS-1 program of Swofford and Selander (1981) was used to analyse allele frequency data. Phenetic analysis was carried out using Nei's genetic distance (Nei 1978) and the UPGMA hierarchical clustering technique of Sneath and Sokal (1973). Phylogenetic analysis was carried out using the modified Rogers' Distance (Wright 1978) and the Distance Wagner method. Both methods gave similar results, and only the Distance Wagner method is presented here.

TAXON DESCRIPTIONS

Descriptive terminology follows Weston (1990) for inflorescence structure, though we use pedicel instead of anthopodium, and Hewson (1988) and Theobald *et al.* (1979) for trichomes. Conservation codes follow Briggs and Leigh (1996).

CULTIVATION

Plants from Emerald and Torrington, with extremes in trichome density (measured on the adaxial leaf surface), were propagated asexually. Cuttings were prepared from firm young growth and treated with Indole Butyric Acid 3000 ppm. Cuttings formed adventitious roots in 4–6 weeks. These were grown under similar conditions in a glasshouse to determine if trichome density reflects genetic differences or is a response to environmental conditions.

Results and Discussion

MORPHOMETRIC ANALYSIS

Analysis 1 (specimens 1–116, characters 1–14): Analysis 1 included 116 specimens of *A. asteriscophora, A. buckinghamii* and *A. buxifolia*. Both the UPGMA classification (Fig. 2) and the ordination (Fig. 3) indicate two major groups (groups A and B). The high co-phenetic correlation coefficient for the classification (0.722) and the low stress value for the ordination (0.182) indicate a minimal and acceptable loss of information from the original distance matrix. Group A incorporates two type specimens (specimen 116 - lectotype) and (specimen 115 - residual syntype) of *A. buxifolia* from the Blue Mountains, New South Wales. They are distinct from all other specimens in having a glabrous ovary (character 13), a glabrous adaxial leaf surface (character 5), and globular stellate trichomes on the abaxial surface of petals (character 12).

Group B (specimens 1–114) consists of specimens from New South Wales and Victoria characterised by a stellate indumentum on the ovary (character 13) and adaxial surface of the leaf (character 5), and stalked, multiangular stellate trichomes on the abaxial surface of petals (character 12). The classification indicates that *A. asteriscophora sensu lato* contains a number of subgroups. While the ordination indicates *A. buckinghamii* is a distinct group, other subgroups identified in the classification are not as clearly separated due to the compression of ordination space by the inclusion of *A. buxifolia*. Therefore the data were re-analysed omitting *A. buxifolia.*

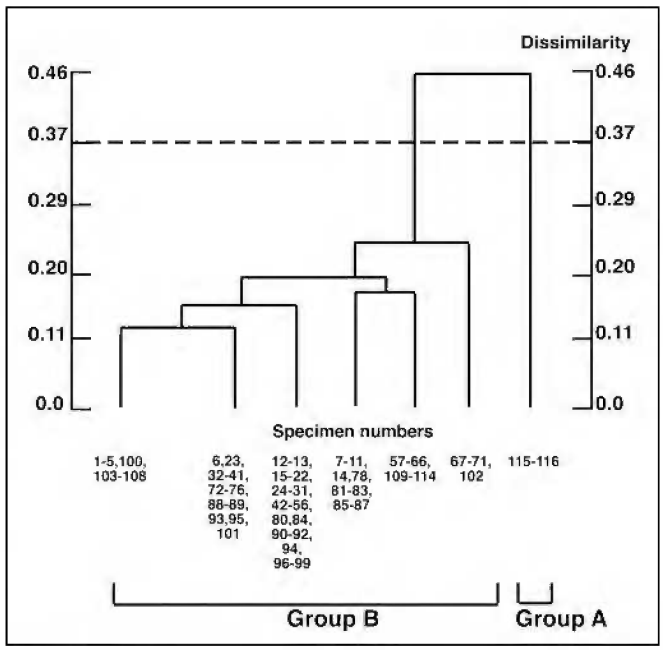

Figure 2. UPGMA classification, analysis 1, specimens 1–116, truncated as indicated by the dashed line. Group A: *Asterolasia buxifolia*. Group B: *A. buckinghamii*, and *A. asteriscophora*. Co-phenetic correlation coefficient = 0.722.

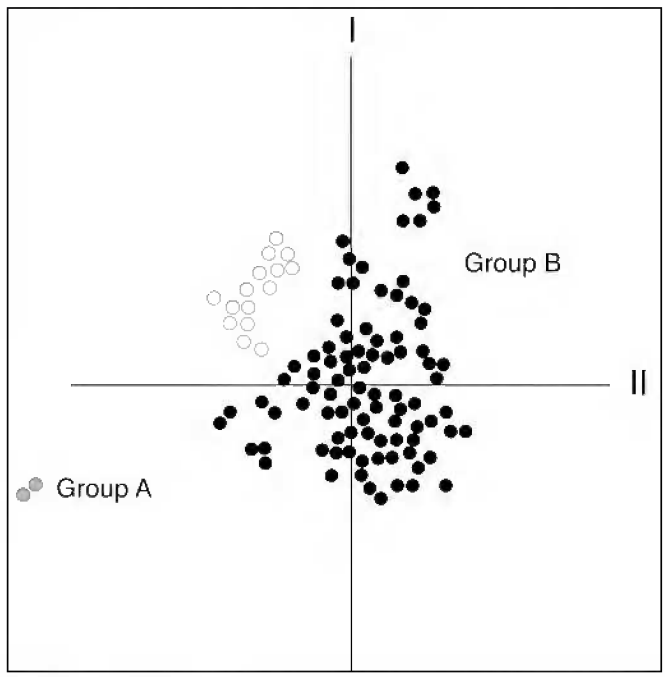

Figure 3. NMDS ordination, vector I versus vector II, analysis 1, specimens 1–116. Symbols are: *Asterolasia buxifolia*, Group A (shaded circles); *A. buckinghamii*, Group B (open circles); *A. asteriscophora sensu lato* Group B (solid circles). Stress = 0.182.

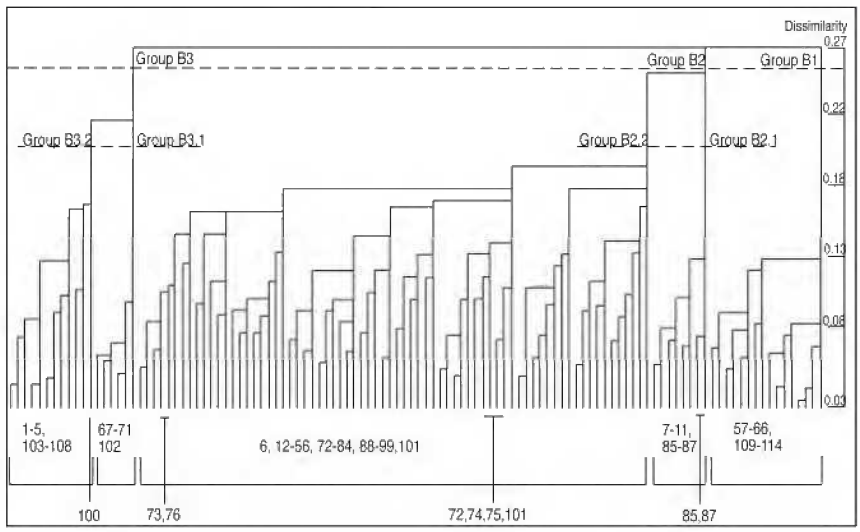

Figure 4. UPGMA classification, analysis 2, specimens 1–114. Co-phenetic correlation coefficient = 0.707. Numbered specimens are referred to in text.

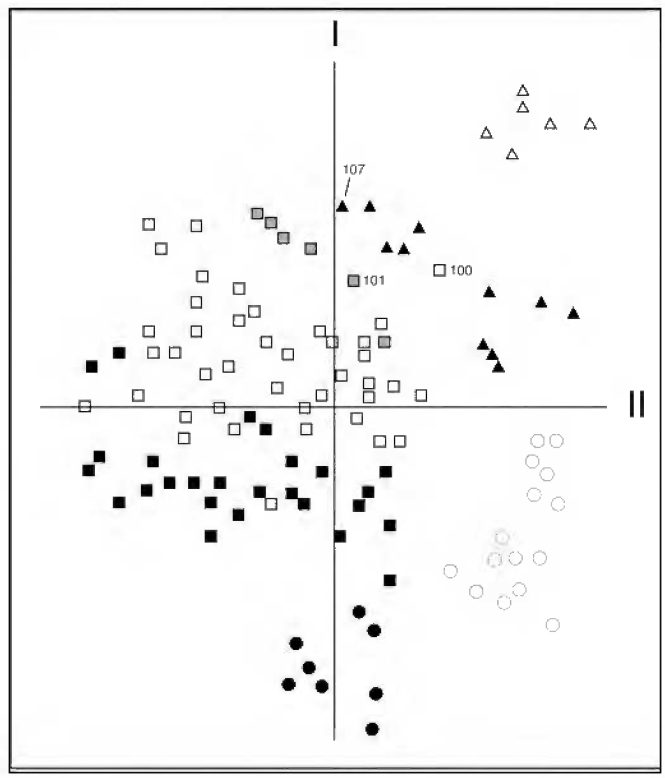

Figure 5. NMDS ordination, vector I verses II, analysis 2, specimens 1–114. Symbols are: *Asterolasia buckinghamii*, Group B1 (open circles); Group B2.1 (solid circles); Group B2.2 Melbourne region (solid squares); Group B2.2 East Gippsland and southern NSW (open squares); Group B2.2 Torrington (shaded squares); Group B3.1 (open triangles); and Group B.3.2 (solid triangles). Numbered specimens referred to in text. Stress = 0.182.

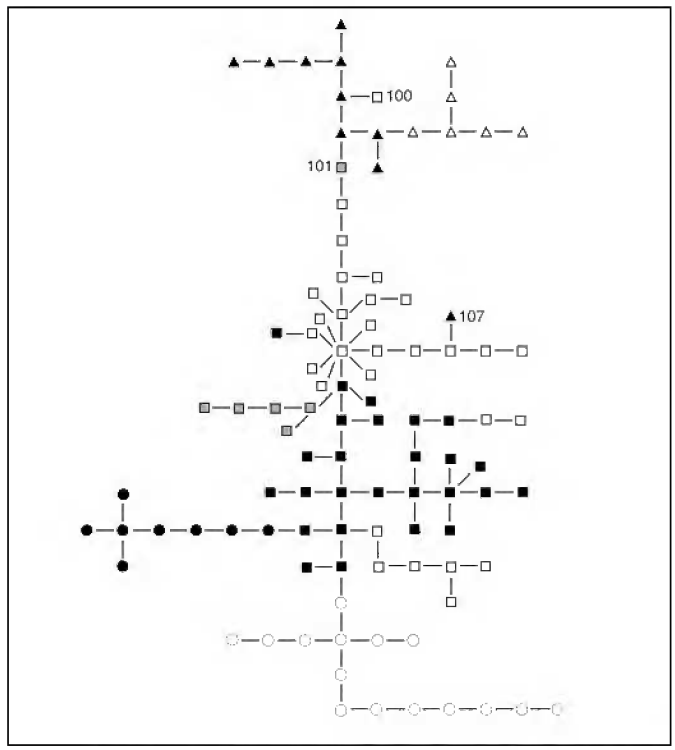

Figure 6. Minimum spanning tree, Analysis 2, specimens 1–114. Symbols are: *Asterolasia buckinghamii*, Group B1 (open circles); Group B2.1 Emerald (solid circles); Group B2.2 Melbourne region (solid squares); East Gippsland and southern N.S.W. tablelands (open squares); Group B.2.2 Torrington (shaded squares); Group B3.1 (open triangles) and Group B3.2 (solid triangles). Numbered specimens are referred to in text.

Analysis 2 (specimens 1–114, characters 1–11, 14): Analysis 2 included the 114 specimens in group B of analysis 1. Characters 12 and 13 were invariate after removal of *A. buxifolia* and were deleted. Data were range standardised before reanalysis. Five groups are evident from the UPGMA classification (Fig. 4), ordination (Fig. 5) and MST: three major groups (groups B1, B2 and B3) and two pairs of subgroups (B2.1 & B2.2 and B3.1 & B3.2). The high co-phenetic correlation coefficient for the UPGMA classification indicates that the branch lengths in the dendrogram are highly correlated with the distances in the original distance matrix. Group B1 (specimens 57–66, 109–114) corresponds to *A. buckinghamii*. Groups B2 and B3 represent two different forms within *A. asteriscophora sensu lato*. Group B2 includes specimens from the Emerald district of Victoria (B2.1) and a widespread group that contains the lectotype of *A. asteriscophora* (B2.2). Group B3 includes specimens from the Armidale region of New South Wales (B3.1) and the Mt Kaputar and Mt Canobolas districts of New South Wales (B3.2). In the ordination, specimens from Torrington are positioned on the periphery of group B2.2 (typical *A. asteriscophora*), and adjacent to group B3 (Mt Kaputar and the Armidale region) indicating they have similarities to both groups. However, the Torrington specimens cluster with Victorian and southern New South Wales specimens in group B2 in the UPGMA classification (Fig. 4), which is supported by the Minimum Spanning Tree (Fig. 6).

The positions of specimens 100, 101 and 107 are problematic. Specimen 101 from Deepwater in New South Wales is positioned between B3.2 and B2.2 in the MST (Fig. 6)

but is included in B2.2 because all other specimens from this region clustered clearly within B2.2. Specimen 107 from Mt Canobolas in New South Wales is considered misplaced in the MST where it is linked to specimens of group B2.2, as it clusters within group B3.2 in the classification and ordination. Otherwise, the MST supports the groups identified in both the classification and the ordination. Specimen 100 from Cabramurra in New South Wales is clustered in group B3.2 in all analyses. However, it does not fit well in this group because, other than the high trichome density and short petiole, it is very similar to specimens in group B2.2, and all other specimens from this region are clustered within B2.2.

Means and Cramer values for the most discriminating continuous characters between groups are given in Table 2.

Table 2. Cramer values, means and ranges for the four most discriminating continuous characters between groups.

Character	Cramer Value		Group Number				
			B1.1	B2.1	B2.2	B3.1	B3.2
Petiole length (mm) (character 4)	0.7263	Mean	3.0	2.5	3.7	0.0	0.5
		Maximum	6.1	3.7	7.0	0.0	1.7
		Minimum	1.8	1.7	1.3	0.0	0.0
Peduncle length (mm) (character 7)	0.8192	Mean	1.0	4.6	7.1	5.8	5.9
		Maximum	1.7	4.9	14.3	6.3	7.7
		Minimum	0.0	3.8	4.6	5.5	4.8
Pedicel length (mm) (character 8)	0.7404	Mean	1.4	8.5	7.8	8.4	11.0
		Maximum	1.9	11.5	3.8	9.3	14.3
		Minimum	0.9	5.7	15.4	7.3	8.9
Flower number per inflorescence (Character 6)	0.8469	Mean	1.1	4.2	4.6	4.6	4.1
		Maximum	2.2	4.8	6.6	5.7	6.0
		Minimum	1.0	3.3	3.0	4.0	3.0

Group B1 (specimens 57–66, 109–114) includes two syntypes (specimens 109 and 110) of *A. buckinghamii* and is distinct from other groups in the analysis by the combination of the following features: flowers solitary or almost so (character 6); a reduced or absent peduncle (character 7; mean 1 mm); a reduced or absent pedicel (character 8; mean 1.4 mm); and petiolate leaves (character 4; mean petiole length 3 mm).

Group B2 (specimens 6–56, 72–101) may be distinguished from group B1 in combining the following features: inflorescence an umbel of three or more (character 6), a peduncle length of 3.5–15 mm (character 7), and a pedicel length of 3.5–15.5 mm (character 8); from group B3 by the longer petiole length (character 4; range 1.7–7 mm), a lower average trichome density on the adaxial leaf surface (character 5), and leaf shape.

Group B2.1 (specimens 7–11, 85–87) consists of those specimens that have white or, very rarely, pale lemon petals (character 14), short petioles (character 4; mean length 2.5 mm), and an obovate to spathulate lamina with a rounded apex.

Group B2.2 (specimens 6, 12–56, 72–84, 88–99, 101) includes the lectotype (specimen 83), and two isolectotypes (specimens 81 and 82) of *A. asteriscophora*. This group is defined by specimens with bright yellow flowers in umbels of three or more (character 6; mean 4.6), long peduncles (character 7; mean 7.1 mm), long pedicels (character 8; mean 7.8 mm) and petiolate leaves (character 4; mean petiole length 3.7 mm) that are elliptic to spathulate, with a rounded apex.

Group B3 (specimens 1–5, 67–71, 100, 102–108) is readily distinguished from group B1 in combining the following features: inflorescence an umbel of three or more (character 6), a peduncle length of 4.5–8 mm (character 7), and a pedicel length of 7–15 mm

(character 8); from group B2 by the short or absent petiole (character 4) and a higher average trichome density on the adaxial leaf surface (character 5).

Group B3.1 (specimens 67–71, 102) contains specimens distinguished by the combination of the following characters: leaves sessile or almost so (character 4), obcordate to obdeltate, margins strongly recurved (character 11), high trichome density (character 5; mean 21 trichomes per mm^2), and a shorter leaf length/distance to widest point (character 3) than all other groups.

Group B3.2 (specimens 1–5, 100, 103–108) is defined by the same characters as group B3.1, but differs in the subsessile leaves (character 4, mean petiole length 0.5 mm), and the non-recurved leaf margins (character 11).

These five groups (B1, B2.1, B2.2, B3.1 and B3.2) correspond to geographic regions. Specimens in group B1 are all from the Penrose, Wingello and Berrima districts of the central tablelands of New South Wales. Specimens in group B2.1 are all from a small area in the Emerald-Avonsleigh district of Victoria. Group B2.2 has the largest distribution, ranging from the Macedon district north of Melbourne to the southern tablelands of New South Wales. There is a disjunct occurrence of group B2.2 at Torrington in northern New South Wales. Interestingly, this population is more similar to specimens from the southern New South Wales tablelands and Victoria than it is to other northern New South Wales populations (group B3). Specimens in group B3.2 are restricted to Mt Kaputar NP in northern New South Wales, while specimens in group B3.1 occur near Palour Mountain north west of Armidale in New South Wales. The recognised groups do not overlap geographically.

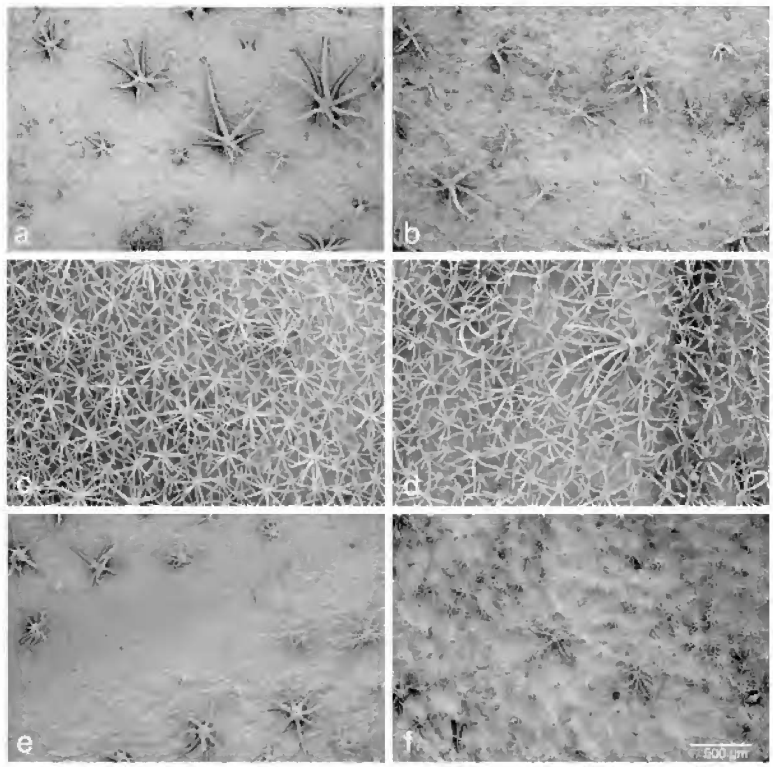

Figure 7. Adaxial leaf surfaces, illustrating variation in density of stalked, multiangular, stellate trichomes. (a – d) *Asterolasia asteriscophora sensu lato* (e – f) *A. buckinghamii*: (a) specimen 11 from Emerald; (b) specimen 77 from Wallaby Creek; (c) specimen 2 from Mt Kaputar; (d) specimen 73 from Torrington; (e) specimen 62 from Mittagong; and (f) specimen 57 from Medway.

The ordination identifies variation in trichome density, with a trend in Groups B2 and B3 of increasing density on the adaxial leaf surface correlated with decreasing latitude, although latitude per se is unlikely to be the causal factor. Specimens from the greater Melbourne region have the lowest average trichome density, while specimens from Torrington and Mt Kaputar have the highest (Fig. 7). Indumentum density correlating with latitude change was also observed in *Boronia grandisepala* F.Muell *sensu lato*. (Duretto & Ladiges 1997), where increased indumentum density correlated with increased aridity. Cultivated *A. asteriscophora* plants originating from Torrington and Emerald growing under controlled glasshouse conditions were observed to have similar trichome densities to specimens sampled from those populations in the field.

ISOZYME ANALYSIS

Four enzyme systems corresponding to seven loci were resolved. These were: AAT (one locus); FUM (two loci); GPI (two loci); and PGM (two loci). An additional locus for AAT was scored for phenotype only. The low number of enzyme systems resolved is insufficient to describe genetic diversity between populations. However, with the exception of *A. buckinghamii*, the results broadly correlate with morphological results.

Problems were encountered with the resolution of some enzyme banding patterns making interpretation of allele mobility difficult. A characteristic of the Rutaceae is the presence of aromatic volatile oils in the pellucid oil glands of the leaves. It appears that these oils and/or other unknown compounds have co-migrated with some alleles during electrophoresis making interpretation of band patterns difficult. Similar problems to those encountered in this study have been documented in other studies of Rutaceae (eg. Durham 1998). There were difficulties in particular with interpreting the AAT system. AAT is a dimeric system where a homozygote is represented by one band and a heterozygote by three. The number of bands for individuals ranged from two to four. However, it was decided to interpret the different banding patterns as phenotypes, and record the frequencies of each. This method has previously been used by Faville *et al.* (1995) in a study on allozyme variation in the grass *Agrostis capillaris*L. In addition, the need to freeze some samples reduced enzyme activity in those samples and resulted in fewer enzyme systems being satisfactorily resolved. Consequently, only results for populations from the Melbourne region are presented here, although allele frequency data for all populations are recorded in Table 3.

A Distance Wagner Tree (Fig. 8) for populations of *A. asteriscophora* in the greater Melbourne region based on four enzyme systems and seven loci (Table 3) indicates that these populations are genetically very similar. The distances in the Wagner Tree correlate

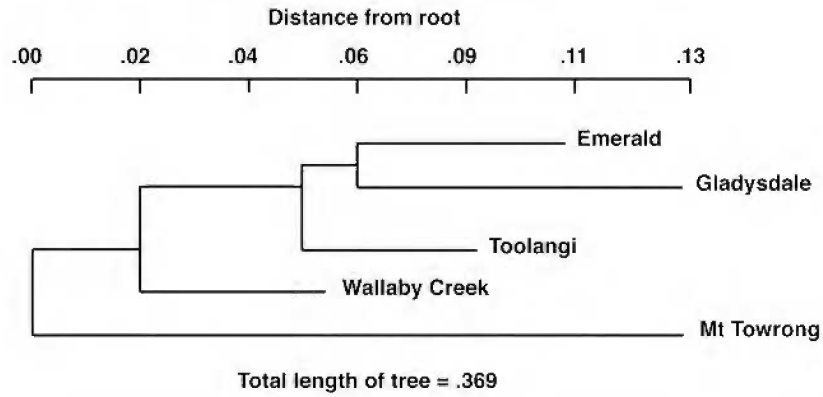

Figure 8. Wagner Tree for isozyme data rooted at the midpoint for five populations of *Asterolasia asteriscophora* in the Melbourne region. Co-phenetic correlation coefficient 0.974.

with the geographic isolation of these populations from one another. The Mt Towrong population near Macedon is the most distinct and also the most geographically isolated population. The population with white petals from Emerald is not distinct based on these four enzyme systems, but is distinct based on analysis of phenotype for AAT.

Table 3. Allele frequencies for 13 populations of *Asterolasia.* Sample size per locus = 15 individuals. Populations are: 1–7 *A. asteriscophora sensu lato* Victorian populations, 1 Emerald; 2 Gladysdale; 3 Toolangi; 4 Wallaby Creek; 5 Mt Towrong; 6 Mt Bowen; 7 Ben Cruachan Creek. 8–12 *A. asteriscophora sensu lato* New South Wales populations, 8 Mt Kaputar; 9 Torrington; 10 Mittagong; 11 Medway; 12 Tumut River. 13 *A. correifolia* Boonoo Boonoo New South Wales.

Locus	Allele	Population number												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Pgm-1	1	0	0	0	0	0.466	0	0.833	0	0.5	0.04	0	0.133	0
	2	1	1	1	0.844	0.533	0.833	0.177	0.1	0.5	0.966	1	0.877	1
	3	0	0	0	0.166	0	0.177	0	0.9	0	0	0	0	0
Pgm-2	1	0	0	0	0	0.1	0	1	1	0	0	0	0	0.5
	2	1	1	1	0.893	0.9	0.714	0	0	1	1	0.8	0.846	0.5
	3	0	0	0	0.107	0	0.286	0	0	0	0	0.2	0.154	0
Gpi-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gpi-2	1	0	0	0	0	0	0	0	0.466	0	0	0	0	0
	2	0	0	0.033	0.2	0.2	0.233	0	0	0	0	0.7	0.1	0.5
	3	0.633	0.8	0.466	0.5	0.733	0.777	0.633	0.544	0	0.633	0	0.633	0.5
	4	1	0.166	0.266	0.1	0.033	0	0	0	0.433	0	0.044	0.1	0
	5	0.233	0	0.166	0.166	0.033	0	0.377	0	0.577	0.377	0.266	0.177	0
	6	0	0.033	0.066	0.033	0	0	0	0	0	0	0	0	0
Fum-1	1	0	0.033	0	0	0	-	-	-	-	-	-	-	-
	2	0.133	0.033	0	0	0	-	-	-	-	-	-	-	-
	3	0.867	0.933	1	1	1	-	-	-	-	-	-	-	-
Fum-2	1	0	0	0.066	0.033	0.167	-	-	-	-	-	-	-	-
	2	0.9	1	0.934	0.967	0.833	-	-	-	-	-	-	-	-
	3	0.1	0	0	0	0	-	-	-	-	-	-	-	-
Aat-1	1	1	1	1	1	1	-	-	-	-	-	-	-	-

Taxonomic conclusions

Morphological analyses have contributed to elucidating two major (groups B2 & B3) and four minor groups (groups B2.1, B2.2, B3.1 & B3.2) within *Asterolasia asteriscophora sensu stricto*, and confirm that specific status for *A. buxifolia* (group A) and *A. buckinghamii* (group B1) is appropriate. Although there is insufficient information to describe genetic diversity between populations based on isozyme analyses due to the low number of enzyme systems resolved, fixed allele differences support the morphological findings.

In the classification proposed here, Group B2 and B3 are recognised at the species level. Group B2 corresponds to *A. asteriscophora*, and the subgroups B2.1 and B2.2 are recognised here as subspecies. Group B2.2 contains the type for *A. asteriscophora*, therefore it is designated *A. asteriscophora* subsp. *asteriscophora*. Group B2.1 is recognised here as *A. asteriscophora* subsp. *albiflora* B.J.Mole. It is given sub-specific rank because, other than petal colour, it is morphologically similar to typical *A. asteriscophora*. Petal colour has been used as a character to delimit species of *Asterolasia* in Western Australia

(Wilson 1980). Specimens 85 and 87 (Fig. 4) sampled near the white-petalled population over 10 years ago, have flowers which are very pale lemon in colour, indicating specimens from this locality may grade into typical *A. asteriscophora.* During subsequent field work at these localities, however, only white-petalled individuals were observed. Some white-petalled specimens collected at this site during field work for this research (*Mole 73–77*) had discoloured to a pale lemon colour 12 months after pressing. In some cases petals may turn pale lemon on drying, however information recorded on specimen 87 would indicate flower colour for that specimen was "pale lemon" at the time of collection. Even so, it is considered by the authors and the collector of that specimen (Walsh 2001 pers. comm.) to be consistent in other characters with white flowering specimens from the same locality. *Asterolasia asteriscophora* subsp. *albiflora* is geographically isolated from the typical subspecies and commences flowering several weeks earlier than populations of the latter in the Melbourne area. This characteristic has been observed over several years (Gross 1998 pers. comm.). Isozyme phenotype differences for Aspartate aminotransferase locus 2 (*Aat-2*) distinguish *A. asteriscophora* subsp. *albiflora* from the typical subspecies.

Specimens from the Torrington region are assigned to *A. asteriscophora* subsp. *asteriscophora* as the ordination for morphological data (Fig. 5) places them with, but peripheral to, specimens in this taxon, despite their geographic proximity to group B3 described below. Both the MST and the classification also support the inclusion of Torrington specimens in subsp. *asteriscophora.* Isozyme frequency data (Table 3) also indicate that specimens from Torrington are more similar to southern populations of *A. asteriscophora* (although still distinct from them) than they are to the Mt Kaputar population (group B3.2).

Group B3 constitutes a new species, *Asterolasia rupestris* B.J.Mole, and the two subgroups within group B3 constitute subspecies. *Asterolasia rupestris* includes specimens from Mt Kaputar NP (group B3.2, specimens 1–5, 103–105), Mt Canobolas (group B3.2, specimens 106–108) and the Parlour Mountains (group B3.1, specimens 68–71, 102). *Asterolasia rupestris* differs from typical *A. asteriscophora* in having obcordate leaves and a reduced or absent petiole. *Asterolasia rupestris* subsp. *rupestris* (group B3.2), represented by specimens from Mt Kaputar and Mt Canobolas, has plane leaf margins and *A. rupestris* subsp. *recurva* B.J.Mole. (group B3.1), represented by specimens from The Parlour Mountains near Armidale, has recurved leaf margins. The differences in leaf margins were consistently distinct between specimens assigned to each subspecies. The specimens from Mt Canobolas in New South Wales are somewhat intermediate between *A. rupestris* and *A. asteriscophora* in that the leaves are narrowly obcordate. They are included in *A. rupestris* because of the short or absent petiole (character 4), high trichome density (character 5) and a leaf length:distance to widest point ratio (character 3) which is greater than that of *A. asteriscophora.*

Key to the *A. asteriscophora sensu lato* group.

1. Flowers usually solitary and subsessile (rarely in umbels of two or three and then only occasionally on each individual plant); peduncles absent or to 2 mm long, pedicel length at anthesis 0–2 mm long
   2. Adaxial surface of the leaves glabrous; abaxial surface of petals with an indumentum of sessile, globular stellate trichomes; ovary glabrous .....**1. *A. buxifolia***
   2: Adaxial surface of the leaves with an indumentum of stalked multiangular stellate trichomes; abaxial surface of petals with an indumentum of stalked multiangular stellate trichomes; ovary with an indumentum of multiangular, stellate trichomes .....**2. *A. buckinghamii***

1: Flowers in umbels of three or more (usually five); peduncles 3–15 mm long; pedicel length at anthesis 3–15 mm long
   3. Leaves sublanceolate, elliptic-obovate, or sometimes spathulate, adaxial surface sparsely or densely covered with stellate trichomes, petiole (2–)4–7mm

long; petiole terete, not appressed to the stem; the base of lamina often adaxially V-shaped in section, giving the appearance of an extended petiole..... .....**3. *A. asteriscophora***

4. Petals bright yellow.....**3a. *A. asteriscophora* subsp. *asteriscophora***

4: Petals white, rarely pale lemon .....**3b. *A. asteriscophora* subsp. *albiflora***

3: Leaves obcordate to obdeltate, adaxial surface densely covered with stellate trichomes, sessile or petiole < 2 mm long, when present somewhat thickened and flat, often appressed to the stem; the lamina base not adaxially V-shaped in section.....**4. *A. rupestris***

5. Leaf margins not recurved.....**4a. *A. rupestris* subsp. *rupestris***

5: Leaf margins strongly recurved .....**4b. *A. rupestris* subsp. *recurva***

Taxonomy

1. *Asterolasia buxifolia* Benth., *Fl. Austral.* 1: 351 (1863); *Eriostemon cunninghammii* F.Muell., *Fragm.* 9: 107 (1875). *Type*: Bells Road, Blue Mountains, N.S.W., 1834, *R.Cunningham* (lectotype K, *fide* Wilson, *Nuytsia* 12: 83–88, 1998); Botanic Gardens Sydney, 1839, *A.Cunningham s.n.* (residual syntype MEL *4546*).

Shrub to 2 m high. *Stems* with a dense indumentum of stellate trichomes. *Leaves* obovate, 10–18 mm long, 3–10 mm wide, coriaceous, apex rounded or slightly emarginate; adaxial surface glabrous; abaxial surface with an indumentum of stalked, multiangular, stellate trichomes; petiole 2–7 mm long. *Flowers* axillary, solitary; peduncles absent; pedicels 1–1.5 mm long, subtended by two white petaloid bracts. Sepals inconspicuous, c. 1 mm long. Petals five, elliptic, 6–7 mm long, yellow; abaxial surface with an indumentum of sessile, globular, stellate trichomes; adaxial surface glabrous. Stamens 10, filaments glabrous; anthers 1–1.5 mm long, each with a terminal gland. Carpels five, glabrous; style glabrous; stigma hemispherical. *Cocci* glabrous, beaked. *Seed* not seen.

Additional specimens examined: NEW SOUTH WALES: 1838, Anonymous (MEL *708653*); "Port Jackson", 1838, Theod. Scenes [sic.] ex herb. Sond. (NSW *468151*); Blue Mountains, *Vicary s.n.* (MEL *708652*, MEL *708654*); New Holland, *Anderson 52* (MEL *4827*); Blue Mountains, Hartley area, October 2000, *R.O.Makinson 1791* (CANB *n.v.*, MEL, NSW *n.v.*).

Distribution and conservation status: *Asterolasia buxifolia* was presumed extinct because it had not been located in the field since the 1830s and recent attempts to relocate it in the Blue Mountains had not been successful (Wilson 1998; Keith Ingram 1999 pers. comm.). However, a collection of the species that is consistent with the type specimen was made in October 2000 in the Hartley area of the Blue Mountains (B. Makinson pers comm.; Auld 2001; Benson & McDougall 2001). A conservation code of 2E is considered appropriate because the taxon is currently known from only one population of between 50–100 individuals (B. Makinson pers comm.).

Habitat: The species is apparently restricted to rocky watercourses, with a granitic substrate.

Phenology: Flowering specimens have been collected in October.

Etymology: The specific epithet *buxifolia* presumably means foliage like the genus *Buxus*, however there is no particular resemblance between the leaves of *A. buxifolia* and those in the genus *Buxus*.

2. *Asterolasia buckinghamii* (Blakely) Blakely, *Austral. Naturalist* 11: 12 (1941); *Phebalium buckinghamii* Blakely, *Austral. Naturalist* 10: 246 (1940). *Type citation:* "Gold Gully, Penrose, W.F.Blakely, Jeane and W.J.Buckingham, and E.Murphy, 15/10/1938; *2 miles N.E. of Wingello railway station, same collectors, 30/9/1939.*" *Type*: Gold Gully Penrose [N.S.W], 15.x.1938, *W.F.Blakely, J. and W.J.Buckingham and*

E.Murphy (lectotype, here designated, NSW *2214*; isolectotypes MEL *232746*, CANB *81750 n.v.*); 2 miles [c. 3.2 km] NE of Wingello railway station, 30.x.1939, *W.F.Blakely, W.J.Buckingham and E.Murphy* (residual syntype NSW *468135*).

Slender upright *shrub* to 1.5 m high. *Stems* covered with an indumentum of stellate trichomes. *Leaves* orbicular to broadly obovate, 4–15 mm long, 3–7 mm wide, lateral halves adaxially concave, apex rounded to slightly emarginate; adaxial surface with a sparse to dense indumentum of stalked, multiangular, stellate trichomes (range 1–23 trichomes per mm^2); abaxial surface with a cobwebbed indumentum of stalked, multiangular, stellate trichomes; petiole 2–4 mm long. *Flowers* axillary or terminal, usually solitary, rarely in a two or three flowered umbel; peduncle 0–2 mm long; pedicel 0–2 mm long. Sepals inconspicuous, to 0.5 mm long. Petals five, elliptic, 4–8 mm long, yellow; abaxial surface with an indumentum of multiangular stellate trichomes; adaxial surface glabrous. Stamens 10, filaments glabrous; anthers 1–1.5 mm long, each with a terminal gland. Carpels 5; ovary stellate-tomentose; style glabrous; stigma hemispherical. *Cocci* beaked. *Seed* not seen.

Additional specimens examined: NEW SOUTH WALES: Medway Colliery, 10.x.1991, *M. Kennedy 153* (NSW *249646*); c. 1.5 km north of Mittagong P.O., 27.vii.1995, *S.Donaldson 560, G.Corsini and J.Toby* (CANB *9513536*); Flying Fox Road SW of Medway, 22.xii. 1995, *G.Errington 30* (NSW *264105*); Medway area, 18.x.1998, *B.J.Mole 155–160 and C.A.Mole* (*BJM155* - MEL, MELU, NSW; *BJM156–160* - MEL); Nattai River, Mittagong area, 19.x.1998, *B.J.Mole 161–165 and C.A.Mole* (*BJM161* - BRI, CANB, MEL, MELU, NSW; *BJM162–165* - MEL).

Distribution and conservation status: Asterolasia buckinghamii has been recorded from five localities (from Mittagong south to Penrose and Wingello) in the Central Tablelands of New South Wales. Two populations were located during this study at Mittagong and Medway. The population at Medway consisted of less than 30 individuals, while the population at Mittagong consisted of more than 200 individuals but was restricted to a small area, approx $100m^2$. Populations from the type locality near Penrose and Wingello were not located during this study despite searches in these areas during October and November of 1998. This region has been extensively cleared for agriculture and silviculture, and further fieldwork is recommended to establish the status of the species at this locality. A tentative conservation code of 2E is considered appropriate because the species has a geographic range of less than 100 km^2, is currently known from only two localities, and because no plants are known to occur within a conservation reserve.

Habitat: Populations from the type locality and the Nattai River north of Mittagong are recorded as growing in gullies, on river flats in sandy alluvial soils derived from sandstone, the Mittagong population also extending up a gentle north west facing slope for c. 100 m. The vegetation community at the Mittagong locality is riparian on the river flats grading to open-forest further upslope. The population at Medway, however, occurs on a south facing slope at the top of a cliff in shallow soils over sandstone in open-forest. The species therefore is not restricted to damp localities, as previously thought (Blakely 1940).

Phenology: Flowering plants have been collected from early October to late November.

Notes: This species differs from *A. asteriscophora* by the usually solitary flowers and the smaller (often absent) peduncles and pedicels, and from *A. buxifolia* by the stellate trichomes on the ovary and abaxial surface of leaves, and the type of indumentum on the abaxial petal surface.

Etymology: The specific epithet honours one of the collectors of the type specimen, Mr William J. Buckingham of Lindfield, New South Wales.

3. *Asterolasia asteriscophora* (F.Muell.) Druce, *Bot. Soc. Exch. Club Brit. Isles* 4: 606 (1917); *Phebalium asteriscophorum* F.Muell., *Trans. & Proc. Victorian Instit. Advancem.*

Sci. 31 (1855); *Asterolasia muelleri* Benth., *Fl. Austral.* 1: 350 (1863), *nom. illeg*; *Asterolasia correifolia* var. *muelleri* Maiden & Betche, *Proc. Linn. Soc. New South Wales* 26: 80 (1901). *Type:* Mt Disappointment, October 1852, *F.Mueller s.n.* (lectotype MEL *708656*, *fide* Wilson, *Nuytsia* 12: 84, 1998; isolectotypes MEL *708636*, MEL *708637*, MEL *708638*).

Slender, upright *shrub* to 2 m high. Younger *stems* densely stellate-tomentose, indumentum becoming sparse with age. *Leaves* obovate-elliptic or spathulate, 4–35 mm long, 3–15 mm wide, papery, apex rounded, rarely obtuse or slightly emarginate, flat or slightly concave adaxially; adaxial surface with a sparse or dense indumentum of multiangular, stellate trichomes (range = 1–28 trichomes per mm^2); abaxial surface cobwebbed with stalked, multiangular, stellate trichomes; petiole 2–7 mm long. Inflorescence a terminal or axillary umbel of 3–8 *flowers*; peduncles 3–11 mm long; pedicels 3–15 mm at anthesis, longer in fruit. Sepals inconspicuous, 0.5–1 mm long. Petals 5, elliptic 4–9 mm long, bright yellow, pale lemon or white; abaxial surface with an indumentum of stellate trichomes; adaxial surface glabrous. Stamens 10; filaments glabrous; anthers 1–1.5 mm long each with a terminal gland. Carpels 5; ovary stellate; style glabrous; stigma hemispherical. *Cocci* beaked. *Seed* oblong, 2–2.5 mm long, 1–1.2 mm wide, testa smooth, black and shiny; endocarp thin and brittle, a dull mustard colour, deciduous from seed (Fig 9a–h).

Distribution: This species is widely distributed, although often in small disjunct populations, along the Great Dividing Range from the Macedon and Emerald districts in Victoria, to the Tumut district in the Southern Tablelands of New South Wales. The species also occurs disjunctly in the Torrington district in the Northern Tablelands of New South Wales.

Habitat: The species is found in a range of vegetation types, including low open-forest, open-forest and riparian communities and is known to occur on a various substrates including krasnozem soils, alluvial soils, granitic sands and skeletal rocky ridgetops.

Notes: *Asterolasia asteriscophora* differs from *A. buckinghamii* by its three or more flowered umbels, and longer peduncles and pedicels, and from *A. buxifolia* by the stellate trichomes on its ovaries, stellate adaxial leaf surface, and the multiangular stellate trichomes on the abaxial surfac eof the petals.

Etymology: The specific epithet is derived from the Greek *asterios* (starry) and *phorum* (carrier) referring to the stellate trichomes found on the stems, leaves, petals and ovaries of this species.

3a. *Asterolasia asteriscophora* (F.Muell.) Druce **subsp. *asteriscophora***

Slender, upright *shrub* to 2 m high. *Leaves* obovate-elliptic or spathulate, 6–35 mm long, 3–15 mm wide, papery, apex rounded, rarely obtuse or slightly emarginate, flat or slightly conduplicate; adaxial surface with a sparse or dense indumentum of multiangular, stellate trichomes (range 1–22 trichomes per mm^2); petiole 2–7 mm long. Inflorescence an umbel of 3–8 *flowers*; peduncles 5–11 mm long; pedicels 3–15 mm at anthesis, longer in fruit. Petals elliptic 4–9 mm long, bright yellow (Fig. 9a–f).

Representative specimens examined: NEW SOUTH WALES: Tangster via Deepwater, x.1913, *J.D.Lynch* (NSW *374566*); Geehi region, 4.x.1957, *M.E.Phillips s.n. and J.Raeder-Roitysch* (NSW *262309*); Near Cabramurra, 7.xi.1961, *M.E.Phillips 99* (CANB *005413*); Gilmore Creek, Bago State Forest, 4.xi.1962, *K.Giles s.n.* (NSW *468149*); Dingo Creek, Silent Grove Road north of Torrington, ix.1971, *H.J.Wissmann s.n.* (NE *029226*); Geehi Gorge road, 1.xii.1971, *D.J.Wimbush s.n.* (NSW *261158*); Kosciusko NP Peak River, 100 m upstream of junction with Wildhorse Creek, 31.x.1993, *N.Taws 235 and A.Scott* (CANB *9314794*); Kosciusko NP, Peak River, 6.xi.1993, *N.Taws 239 and A.Scott* (CANB *9314798*, MEL *278248*); Mt Kosciusko NP, Geehi area, 14.x.1998, *B.J.Mole 133–142 and C.A.Mole* (*BJM133* - BRI, MEL, MELU, NE, NSW; *BJM134–142* - MEL); 5.7 km along Elliot Way from O'Hares Rest area towards Cabramurra, 16.x.1998, *B.J.Mole149–153 and C.A.Mole* (*BJM149* - BRI, MEL, MELU, NE, NSW; *BJM150–153* - MEL);

Blather Creek, NNE of Torrington, 21.x.1998, *B.J.Mole 177–181 and C.A.Mole* (*BJM177* - BRI, MEL, MELU, NE, NSW; *BJM178–181* - MEL). VICTORIA: Plenty Ranges, x.1902, *G.Weindorfer s.n.* (MEL *5199*); Upper Genoa River, 28.ix.1947, *N.A.Wakefield s.n.* (MEL *543047*); Upper Genoa River, far East Gippsland, 29.ix.1947, *N.A.Wakefield s.n.* (MEL *709144*); Upper Genoa River, 25.ix.1948, *N.A.Wakefield 3201* (MEL *543046*); Wallaby Creek, x.1952, *D.H.Ashton s.n.* (MELU *14864*); Cascades, Kinglake West, 11.x.1962, *A.M.Gill s.n.* (MELU *19798*); Pine Mt, 17.xi.1964, *J.H.Willis s.n.* (MEL *709146*); Far north-east, Black Mt top of Mount Burrowa, 17.xi.1971, *J.H.Willis s.n.* (MEL *502061*); Mt Bowen, East Gippsland, 28.xi.1984, *D.Parkes EG217* (MEL *678435*); Burrowa-Pine Mt NP, 14.xi.1988, *F.E.Davies 677, M.J.Winsbury and S.Donaldson* (CANB *8804043*, MEL *228142*); East Gippsland, Yambulla Creek, 8.ix.1988, *D.E.Albrecht 3699* (MEL *268505*); Yambulla Creeek, 1 km upstream of its confluence with Genoa River, 9.ix.1988, *N.G.Walsh 2126, D.E.Albrecht and J.Westaway* (MEL *268564*); Pine Mtn, 20.ix.1998, *B.J.Mole 71* (MEL); Hazeldene Road south of Gladysdale, 8.x.1998, *B.J.Mole 78–82* (*BJM78* - CANB, MEL, MELU, NE, NSW; *BJM79–82* - MEL); Toolangi, Chum Creek Road, 8.x.1998, *B.J.Mole 85–89* (*BJM85* - CANB, MEL, MELU, NE, NSW; *BJM86–89* - MEL); west side of Mt Towrong, Mt Macedon Regional Park, 11.x.1998, *B.J.Mole 90–94 and C.A.Mole* (*BJM90* - CANB, MEL, MELU, NSW; *BJM91–94* - MEL); Ben Cruachan Creek NW of Ben Cruachan summit, 12.x.1998 *B.J.Mole 98, 100–103 and J.B.Mole* (*BJM98* - CANB, MEL, MELU, NE, NSW; *BJM100–103* - MEL); East Gippsland, Pheasant Creek Track, 12.x.1998, *B.J.Mole 111–119 and J.B.Mole* (*BJM111* - CANB, MEL, MELU, NSW; *BJM112–119* - MEL); East Gippsland, Warbisco Track [Mt Bowen], 13.x.1998, *B.J.Mole 123–132 and J.B.Mole* (*BJM123* - CANB, MEL, MELU, NSW; *BJM124–132* - MEL); Mt Kosciusko NP, Geehi area, 14.x.1998, *B.J.Mole 133–142 and J.B.Mole* (*BJM133* - CANB, MEL, MELU, NSW; *BJM134–139* - MEL); Mt Buffalo NP, Eurobin Creek Falls, 16.x.1998, *B.J.Mole 144 and C.A.Mole* (MEL, NSW).

Distribution and conservation status: *Asterolasia asteriscophora* subsp. *asteriscophora* is widely distributed, although usually in small disjunct populations, particularly along the Great Dividing Range from the Macedon and Gladysdale districts in Victoria, to the Tumut district in the New South Wales southern tablelands. A disjunct occurrence of the subspecies is known from the Torrington district in northern New South Wales. Populations from Woods Point and the upper Genoa River (Victoria), as indicated by herbarium records, could not be located despite searching in those areas during October and November of 1998. The subspecies is widespread with several populations in national parks and others in proclaimed conservation reserves, and appears to be secure.

Phenology: Flowering specimens have been collected from October to November. Populations of this subspecies in the Melbourne region were observed to commence flowering 3–4 weeks later than *A. asteriscophora* subsp. *albiflora*

3b. ***Asterolasia asteriscophora*** subsp. ***albiflora*** B.J.Mole, *subsp. nov.*

A subspecie typica foliis et floribus generaliter parvioribus, foliis obovatis-spathulatis, pedunculis saepe brevioribus et petalis albis differt.

It differs from the typical subspecies in the generally smaller leaves and flowers, obovate - spathulate leaves, frequently smaller peduncles, and white petals.

Type: Victoria, Emerald - Avonsleigh Road, Southern end of Country Club golf course, 8.x.1998, *B.J.Mole 73* (holotype MEL *2120867*; isotypes CANB, MEL *2068578*, MELU, NE, NSW).

Eriostemon spathulifolius Gand., *Bull. Soc. Bot. France* 60: 458 (1913). Type citation: "Australia, Victoria ad Esmerald [probably Emerald], *MacLennan, n.v.* (possibly at LYON *fide* Paul G. Wilson pers. comm.). Equated with *A. asteriscophora* 'form of *Asterolasia* found at Emerald...' by Wilson (1970, p. 120).

Slender, upright *shrub* to 1.5 m high. *Leaves* obovate to spathulate, 4–16 mm long, 3–12 mm wide, flat, apex rounded, adaxial surface with a sparse (1–3 trichomes per mm^2) indumentum of multiangular, stellate trichomes; lamina papery; petiole 1–4 mm long. Inflorescence an umbel of 3–5 *flowers*; peduncles 3–5 mm long; pedicels 6–15 mm at

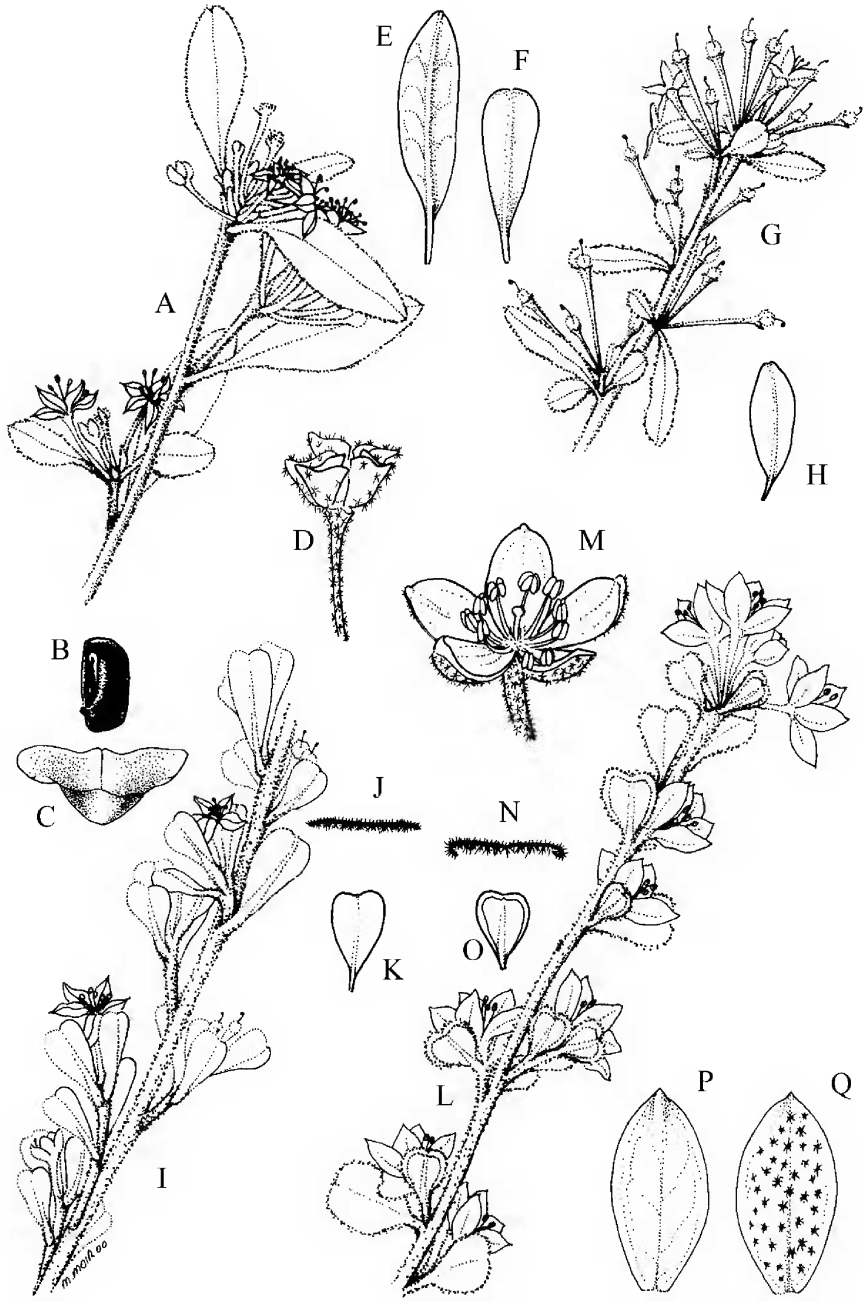

Figure 9. **a–e** *Asterolasia asteriscophora* subsp. *asteriscophora* (*Mole 100*): **a** Flowering sprig × 1; **b** Seed × 5; **c** Endocarp × 5; **d** Fruits × 4; **e** Leaf (abaxial view) × 1. **f** Leaf of *A. asteriscophora* subsp *asteriscophora* (*Mole 177*). **g–h** *A. asteriscophora* subsp. *albiflora* (*Mole 75*): **g** Flowering sprig × 1; **h** Leaf (abaxial view) × 1.5. **i–k** *A. rupestris* subsp. *rupestris* (*Fox s.n.* CANB *406009*): **i** Flowering sprig × 1; **j** Leaf section × 2; **k** Leaf (abaxial view) × 1.5. **l–q** A. *rupestris* subsp. *recurva* (*Mole 172*): **l** Flowering sprig × 1; **m** Flower × 2; **n** Leaf section × 2; **o** Leaf (abaxial view) × 1.5; **p** Petal (adaxial view) × 2.5; **q** Petal (abaxial view) × 2.5.

anthesis, longer in fruit. Petals elliptic, 4–6 mm long, white, rarely pale lemon (Fig. 9g–h).

Representative specimens examined: VICTORIA: Emerald, 27.x.1906, *P.R.H.St.John s.n.* (NSW *262302*); Dandenong Ranges, Belgrave, January 1933, *J.H.Willis s.n.* (MEL *709148*); between Beaconsfield and Emerald, 28.ix.1933, *T.S.Hart s.n.* (MEL *709145*); Dandenong Ranges, between Emerald and Avonsleigh, 7.x.1934, *J.H.Willis s.n.* (MEL *709149*); Dandenong Ranges, Emerald-Clematis, 5.x.1945, *A.C.Beauglehole 7016* (MEL *2101021*); Upper Ferntree Gully [locality uncertain, Hemphill pers. comm. 1998], 23.ix.1965, *B.Hemphill s.n.* (MEL *2101022*); Eastern Highlands, Emerald-Monbulk Road, 24.ix.1993, *N.G.Walsh 3507* (MEL *2020508*); Emerald-Avonsleigh Road, southern end of Country Club golf course, 8.x.1998, *B.J.Mole 74–77* (MEL).

Synonymy: *Eriostemon spathulifolius* is probably a synonym of *Asterolasia asteriscophora* subsp. *albiflora* but as the type material was not seen this can not be verified (cf. Wilson 1970; McGillivray 1973). The type for *Eriostemon spathulifolius* is probably at LYON (P.G. Wilson pers. comm. 1998) and was requested in 1998 but has not been located.

Distribution and conservation status: This subspecies is known only from three localities in the Emerald - Avonsleigh district of Victoria, all of which are threatened by urban development. Two of these are located in residential areas, while the third is located within a quarry site. It was previously recorded from Menzies Creek, 'Paradise' and Clematis. The single record from the Grampians (ix.1937, *C. French Jnr. s.n.,* MEL *709143*) is most likely incorrectly labelled. No other record of *A. asteriscophora* is known from the Grampians. A conservation code of 2Ei is appropriate; the subspecies is known from a geographic range of less than 100 km, is in serious risk of disappearing from the wild within 10–20 years if present residential development and associated pressures continue, and is not known to occur within a conservation reserve.

Phenology: This subspecies flowers from early October to late November and has been observed to commence flowering 3–4 weeks earlier than the typical subspecies.

Etymology: The subspecific epithet is derived from the Latin, *albus* (white) and *floreo* (to flower), alluding to the white colour of the petals.

4. *Asterolasia rupestris* B.J.Mole, *sp. nov.*

*Asterolasiae asteriscophora*e (F.Muell.) Druce affinis sed foliis generaliter brevioribus et subsessilibus vel saepe sessilibus, lamina obcordata vel obdeltata et supra dense stellato-tomentosam differt.

Similar to *Asterolasia asteriscophora* but differs in the generally shorter leaves, which are subsessile, or frequently sessile, the obcordate - obdeltate lamina, and the adaxial lamina surface, which is densely stellate.

Type: New South Wales, walking track to the Governor, Mt Kaputar NP, 27.xi.1987, *J.M. Fox s.n.* (holotype CANB *406009*).

Upright *shrub* to 1.5 m tall. *Stems* with a stellate indumentum. *Leaves* shortly petiolate, or frequently sessile; lamina obcordate or obdeltate, 9–20 mm long, 6–15 mm wide, papery, apex emarginate, sometimes truncate, base attenuate, slightly conduplicate, margins recurved or flat; adaxial surface with a dense indumentum of hyaline multiangular stellate trichomes (15–31 trichomes per mm^2); abaxial surface cobwebbed with stalked, multiangular stellate trichomes; petiole when present somewhat thickened and flat, often appressed to the stem. Inflorescence a terminal or axillary umbel of 3–5 *flowers*; peduncles 4–9 mm long; pedicels 6–15 mm long. Sepals inconspicuous, 0.5–1 mm long. Petals 5, elliptic, 5–9 mm long, yellow, abaxial surface with an indumentum of rust coloured stellate trichomes; adaxial surface glabrous. Stamens 10; filaments glabrous; anthers 1–2 mm long, each with a terminal gland. Carpels 5, stellate-tomentose; style glabrous; stigma hemispherical. *Cocci* beaked. *Seed* not seen (Fig. 9i–q).

Distribution: This species is only known from Mt Kaputar and Mt Lindsay in Mt Kaputar NP east of Narrabri, and from near Parlour Mountain northwest of Armidale; all

of these populations are apparently restricted to trachyte outcrops. Collections have been made from Mt Canobolas, southwest of Orange, but is possibly extinct at this location (see notes under *A. rupestris* subsp. *rupestris*).

Phenology: The flowering period for the species is from late September to early November.

Notes: The species was previously included in *A. asteriscophora* (e.g. Porteners 1991; Wilson 1998) from which it can be readily distinguished by the obcordate to obdeltate leaf shape and sessile to subsessile leaves. Specimens from the Mt Kaputar area lodged at CANB have been determined as *Asterolasia sp. nov.* by I.R. Telford and A. Lynne.

Etymology: The specific epithet, which is derived from the Latin *rupestris*, means rock dwelling, and refers to the rocky outcrops to which this species appears to be confined.

4a. ***Asterolasia rupestris*** B.J.Mole subsp. ***rupestris***

Leaves plane. Inflorescence an umbel of 3–5 *flowers*; peduncles 4–6 mm long; pedicels 7–10 mm long. Petals 5–8 mm long (Fig.9i–k).

Representative specimens examined: NEW SOUTH WALES: Mt Lindsay, Nandewar Mountains, 5.xi.1909, *R.H.Cambage s.n.* (NSW *262327*); Springside via Orange, 10.x.1948, *W.E.Giles s.n.* (NSW *262271*); Springside, near Orange, 14.x.1956, *W.E.Giles s.n.* (NSW *468148*); Devils Hole [Mt Canobolas], Towac, 7 miles SW of Orange, 8.xi.1960, *E.F.Constable s.n.* (MEL *2100530*, NE *29227*, NSW *52954*); Eckfords (sic) Lookout, Mt Kaputar NP, 4.ix.1976, *G.L.Harden s.n.* (NE *38917*); The Governor, Mt Kaputar NP, 21.xi.1976, *R.Coveny 8937 and S.K. Roy* (NSW *468152*, CANB *373743*); Eckards Lookout, Mt Kaputar NP, 25.xi.1987, *J.M. Fox 87/111* (CANB *406306*); Mt Kaputar NP, "The Governor", 15.ix.1998, *B.J. Mole 41–51 and W.A. Gebert* (*BJM41* - CANB, MEL, MELU, NE, NSW; *BJM42–51* - MEL).

Distribution and conservation status: This subspecies has been collected from only a small number of localities at Mt Lindsay and Mt Kaputar in Mt Kaputar National Park. A population recorded from Mt Canobolas during the 1950s was not located during this study despite searching in that area during October 1998. The locality recorded on herbarium specimens is now farmland and/or pine plantations, and so, at this locality the taxon is possibly extinct. Further searches of remnant vegetation in the Mt Canobolas area are required to establish the status of the taxon at this locality. A conservation code of 3E is considered appropriate.

Habitat: The subspecies grows in heathlands, shrublands and low open forest on skeletal gravelly soils on trachyte outcrops, tending to favour sheltered positions but also found in exposed sites.

4b. ***Asterolasia rupestris*** subsp. ***recurva*** B.J.Mole, *subsp. nov.*

A subspecie typica lamina recurva differt.

It differs from the typical subspecies in the recurved lamina margins.

Type: New South Wales, northwest of Armidale, 4.2 km north east of Parlour Mtn, 20.x.1998, *B.J.Mole 171 and C.A.Mole* (holotype MEL *2120868*; isotypes CANB, MEL *2068579*, MELU, NE, NSW).

Leaf margins recurved. Inflorescence an umbel of 3–6 *flowers*; peduncles 4–8 mm long; pedicels 8–15 mm long. Petals 6–7 mm long (Fig. 9l–q).

Additional specimens examined: NEW SOUTH WALES: The Parlour, about 6 miles from Booralong, 28.x.1951, *G.L.Davies s.n.* (NSW *374569*); 4.2 km NE of Parlour Mt, 20.x.1998, *B.J.Mole 172–175 and C.A.Mole* (MEL).

Distribution and conservation status: This subspecies is known only to the authors from one locality near Parlour Mountain north west of Armidale, New South Wales. The population is on private land, which the landholders wish to manage for conservation purposes (Brian Hardaker & Jeremy Bruhl, 1998 pers. comm.). Approximately 30–40 plants

were observed at the locality, restricted to an area c. 50 m^2 along a small creek. Further searches in the Parlour Mountain district are required to establish the extent of this taxon. A conservation code of 2E is appropriate as the taxon has a geographic range of less than 100 km^2 and is known only from two collections, both outside a conservation reserve.

Habitat: The subspecies grows in low open forest on skeletal gravelly soils, along gullies.

Etymology: The subspecific epithet refers to the recurved margins of the leaves, characteristic of this subspecies.

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Appendix 1. Specimens and data used in the phenetic analyses of *Asterolasia asteriscophora sensu lato*. Principal collector given only. For continuous characters (see table 1), mean values are shown. Missing data is coded as 999.

Specimen Number	*Collector & Number*	Herbarium & Sheet	Locality Number	CharacterNumber 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	*B.J.Mole 41*	MEL	Mt Kaputar NSW	12.30	1.51	1.33	0.80	19.00	3.50	999	999	6.17	2.19	1	0	1	1
2	*B.J.Mole 44*	MEL	Mt Kaputar NSW	12.10	1.59	1.18	0.50	23.20	3.20	999	999	6.30	1.73	1	0	1	1
3	*B.J.Mole 45*	MEL	Mt Kaputar NSW	13.90	2.07	1.28	0.90	19.60	3.00	999	999	6.60	2.17	1	0	1	1
4	*B.J.Mole 49*	MEL	Mt Kaputar NSW	13.80	1.54	1.23	0.90	19.80	3.75	999	999	4.75	2.38	1	0	1	1
5	*B.J.Mole 51*	MEL	Mt Kaputar NSW	13.00	1.48	1.19	0.70	29.80	3.00	999	999	999	999	1	0	1	1
6	*B.J.Mole 71*	MEL	Pine Mtn. Vic	25.40	2.67	1.52	3.30	10.80	999	999	999	999	999	1	999	999	999
7	*B.J.Mole 73*	MEL	Emerald Vic	16.10	2.50	1.40	2.20	1.60	4.60	3.80	11.50	5.10	1.91	1	0	1	0
8	*B.J.Mole 74*	MEL	Emerald Vic	13.60	2.40	1.78	3.00	2.80	4.80	4.90	8.00	5.50	2.25	1	0	1	0
9	*B.J.Mole 75*	MEL	Emerald Vic	14.40	2.23	1.48	2.30	0.80	4.50	4.80	10.20	4.70	2.16	1	0	1	0
10	*B.J.Mole 76*	MEL	Emerald Vic	12.20	1.66	1.60	3.70	1.80	4.60	4.60	8.00	4.70	1.99	1	0	1	0
11	*B.J.Mole 77*	MEL	Emerald Vic	10.00	1.88	1.18	2.80	1.40	4.00	4.70	6.80	4.50	2.25	1	0	1	0
12	*B.J.Mole 78*	MEL	Gladysdale Vic	16.90	2.72	2.20	3.50	4.80	5.33	5.40	9.10	4.10	1.79	1	0	1	1
13	*B.J.Mole 79*	MEL	Gladysdale Vic	13.10	2.83	1.83	3.90	2.60	4.33	8.20	8.40	5.40	2.38	1	0	1	1
14	*B.J.Mole 80*	MEL	Gladysdale Vic	11.80	2.22	1.93	4.00	4.40	3.20	6.40	6.40	4.30	2.28	1	0	1	1
15	*B.J.Mole 81*	MEL	Gladysdale Vic	19.70	2.81	2.40	5.00	2.60	3.75	6.00	11.00	4.30	1.98	1	0	1	1
16	*B.J.Mole 82*	MEL	Gladysdale Vic	22.20	2.42	1.71	5.00	2.40	4.50	5.10	9.40	4.70	1.89	1	0	1	1
17	*B.J.Mole 85*	MEL	Toolangi Vic	27.10	3.82	2.09	5.30	1.40	5.00	5.40	8.00	5.00	2.23	1	0	1	1
18	*B.J.Mole 86*	MEL	Toolangi Vic	27.80	2.84	2.13	5.20	2.20	4.67	7.00	7.30	5.00	2.30	1	0	1	1
19	*B.J.Mole 87*	MEL	Toolangi Vic	28.30	3.73	2.00	4.80	2.20	4.80	6.70	13.00	6.90	2.53	1	0	1	1
20	*B.J.Mole 88*	MEL	Toolangi Vic	27.40	2.83	2.06	4.10	0.60	4.75	6.10	11.80	6.80	2.63	1	0	1	1
21	*B.J.Mole 89*	MEL	Toolangi Vic	20.80	2.84	2.17	4.80	1.00	5.17	7.60	5.90	5.40	1.98	1	0	1	1
22	*B.J.Mole 90*	MEL	Mt Macedon Vic	21.10	2.17	1.50	4.80	2.80	4.50	999	999	8.13	2.33	1	0	1	1
23	*B.J.Mole 91*	MEL	Mt Macedon Vic	24.70	2.45	1.35	3.50	5.60	5.17	999	999	6.80	1.82	1	0	1	1
24	*B.J.Mole 92*	MEL	Mt Macedon Vic	19.20	1.36	1.46	2.80	1.40	4.00	5.00	5.25	6.70	2.17	1	0	1	1
25	*B.J.Mole 93*	MEL	Mt Macedon Vic	23.60	1.84	1.34	4.30	4.60	3.75	7.67	4.67	7.70	1.81	1	0	1	1
26	*B.J.Mole 94*	MEL	Mt Macedon Vic	23.90	2.02	1.62	5.00	2.60	5.33	999	7.80	7.25	1.89	1	0	1	1
27	*B.J.Mole 98*	MEL	Ben Cruachan Vic	29.10	2.61	2.90	6.60	9.80	5.50	9.20	7.30	6.10	2.06	1	0	1	1

Specimen Number	*Collector & Number*	Herbarium & Sheet	Locality Number	CharacterNumber 1	2	3	4	5	6	7	8	9	10	11	12	13	14
28	*B.J.Mole 100*	MEL	Ben Cruachan Vic	33.90	2.90	2.39	6.40	6.20	4.50	9.70	10.40	5.40	2.38	1	0	1	1
29	*B.J.Mole 101*	MEL	Ben Cruachan Vic	29.40	3.05	2.67	6.80	7.40	5.86	7.70	9.20	4.90	2.25	1	0	1	1
30	*B.J.Mole 102*	MEL	Ben Cruachan Vic	26.30	2.71	2.43	6.20	5.60	5.00	8.60	8.50	4.90	2.35	1	0	1	1
31	*B.J.Mole 103*	MEL	Ben Cruachan Vic	30.40	2.74	2.30	7.00	4.20	4.60	7.40	10.20	4.50	1.88	1	0	1	1
32	*B.J.Mole 111*	MEL	Pheasant Creek Vic	19.70	2.63	1.74	2.50	12.20	3.67	6.30	7.90	7.00	2.47	1	0	1	1
33	*B.J.Mole 112*	MEL	Pheasant Creek Vic	17.00	2.61	1.63	3.40	19.20	3.67	6.00	7.00	6.30	2.27	1	0	1	1
34	*B.J.Mole 114*	MEL	Pheasant Creek Vic	18.50	2.54	1.57	3.30	12.40	5.00	6.40	7.40	5.20	1.80	1	0	1	1
35	*B.J.Mole 115*	MEL	Pheasant Creek Vic	15.40	2.15	1.61	1.40	15.60	3.83	7.10	7.70	5.10	2.00	1	0	1	1
36	*B.J.Mole 119*	MEL	Pheasant Creek Vic	18.20	2.53	1.74	2.90	22.00	4.00	6.50	7.80	7.00	2.21	1	0	1	1
37	*B.J.Mole 123*	MEL	Mt Bowen Vic	16.30	2.01	1.47	2.80	11.60	3.20	5.50	4.10	5.30	2.07	1	0	1	1
38	*B.J.Mole 124*	MEL	Mt Bowen Vic	20.80	2.61	1.71	2.70	14.20	3.20	6.80	4.10	6.40	2.44	1	0	1	1
39	*B.J.Mole 125*	MEL	Mt Bowen Vic	19.50	2.83	1.37	1.30	13.80	3.29	7.60	7.70	4.90	1.71	1	0	1	1
40	*B.J.Mole 126*	MEL	Mt Bowen Vic	16.30	1.70	1.67	4.00	10.80	3.80	6.80	4.10	5.70	1.74	1	0	1	1
41	*B.J.Mole 129*	MEL	Mt Bowen Vic	14.20	1.72	1.63	3.00	19.40	3.60	6.80	6.00	5.50	1.79	1	0	1	1
42	*B.J.Mole 133*	MEL	Geehi NSW	27.50	3.57	1.69	2.50	11.00	4.60	4.67	4.60	5.60	2.01	1	0	1	1
43	*B.J.Mole 135*	MEL	Geehi NSW	26.70	3.12	1.80	4.50	10.40	5.40	7.33	4.80	4.60	1.86	1	0	1	1
44	*B.J.Mole 136*	MEL	Geehi NSW	32.40	3.70	1.83	6.40	10.00	5.60	6.40	7.50	5.80	1.90	1	0	1	1
45	*B.J.Mole 137*	MEL	Geehi NSW	30.10	3.05	1.98	3.10	10.80	6.63	999	5.00	4.50	2.05	1	0	1	1
46	*B.J.Mole 139*	MEL	Geehi NSW	33.50	4.06	1.90	3.00	10.60	5.00	6.50	4.50	5.00	1.78	1	0	1	1
47	*B.J.Mole 144*	MEL	Mt Buffalo Vic	30.70	3.18	2.00	4.20	13.00	4.00	10.00	6.00	6.50	1.75	1	0	1	1
48	*B.J.Mole 145*	MEL	Mt Buffalo Vic	30.10	3.36	2.54	3.60	10.80	4.75	9.00	11.60	4.50	2.03	1	0	1	1
49	*B.J.Mole 146*	MEL	Mt Buffalo Vic	37.80	4.52	1.76	4.40	13.40	3.67	6.67	7.30	4.90	2.17	1	0	1	1
50	*B.J.Mole 147*	MEL	Mt Buffalo Vic	37.20	3.37	1.83	3.50	10.20	4.00	7.00	6.90	5.10	1.93	1	0	1	1
51	*B.J.Mole 148*	MEL	Mt Buffalo Vic	33.40	3.94	1.48	4.00	13.60	4.50	999	12.00	6.30	1.65	1	0	1	1
52	*B.J.Mole 149*	MEL	Tumut River NSW	27.00	3.22	1.52	3.00	7.40	4.88	7.20	9.80	8.20	2.45	1	0	1	1
53	*B.J.Mole 150*	MEL	Tumut River NSW	24.60	2.77	1.83	3.50	5.00	5.89	11.30	9.60	8.00	1.90	1	0	1	1
54	*B.J.Mole 151*	MEL	Tumut River NSW	29.70	4.50	1.63	3.00	6.80	5.17	9.00	8.20	9.00	2.29	1	0	1	1
55	*B.J.Mole 152*	MEL	Tumut River NSW	27.60	3.29	1.56	2.60	5.20	4.00	8.00	9.00	8.20	1.98	1	0	1	1
56	*B.J.Mole 153*	MEL	Tumut River NSW	29.70	3.24	1.75	4.00	6.20	5.17	8.00	11.40	7.20	2.00	1	0	1	1
57	*B.J.Mole 155*	MEL	Medway NSW	14.20	1.90	1.44	4.00	23.00	1.15	1.70	1.30	6.30	2.06	1	0	1	1

Specimen Number	*Collector & Number*	Herbarium & Sheet	Locality Number	CharacterNumber 1	2	3	4	5	6	7	8	9	10	11	12	13	14
58	*B.J.Mole 157*	MEL	Medway NSW	11.90	1.73	1.59	2.90	22.00	1.00	1.40	1.90	7.20	1.97	1	0	1	1
59	*B.J.Mole 158*	MEL	Medway NSW	15.20	1.96	1.80	6.10	18.80	1.00	1.60	1.90	6.70	2.05	1	0	1	1
60	*B.J.Mole 159*	MEL	Medway NSW	10.80	1.74	1.32	3.60	16.20	1.00	0.60	1.90	5.63	2.53	1	0	1	1
61	*B.J.Mole 160*	MEL	Medway NSW	9.80	1.42	1.56	2.90	14.60	1.00	1.50	1.60	6.20	1.90	1	0	1	1
62	*B.J.Mole 161*	MEL	Mittagong NSW	11.20	2.13	1.70	3.20	1.60	1.09	0.80	0.90	5.30	1.91	1	0	1	1
63	*B.J.Mole 162*	MEL	Mittagong NSW	8.60	2.38	1.52	3.20	2.20	2.20	1.10	1.60	5.00	2.27	1	0	1	1
64	*B.J.Mole 163*	MEL	Mittagong NSW	8.60	1.77	1.37	1.90	1.00	1.14	1.10	1.00	6.30	2.36	1	0	1	1
65	*B.J.Mole 164*	MEL	Mittagong NSW	10.90	1.95	1.50	2.70	3.20	1.00	0.90	1.00	5.80	2.34	1	0	1	1
66	*B.J.Mole 165*	MEL	Mittagong NSW	10.60	1.69	1.54	3.20	1.00	1.07	1.30	1.70	7.10	2.06	1	0	1	1
67	*B.J.Mole 171*	MEL	Parlour Mtns NSW	13.90	2.24	1.11	0.00	15.80	4.25	5.50	9.30	7.40	2.01	0	0	1	1
68	*B.J.Mole 172*	MEL	Parlour Mtns NSW	11.70	1.70	1.21	0.00	22.80	4.00	6.30	9.10	7.50	1.88	0	0	1	1
69	*B.J.Mole 173*	MEL	Parlour Mtns NSW	12.40	1.88	1.21	0.00	12.00	4.60	6.00	7.30	6.00	1.73	0	0	1	1
70	*B.J.Mole 174*	MEL	Parlour Mtns NSW	13.90	1.66	1.06	0.00	24.40	4.80	5.80	8.50	8.00	2.00	0	0	1	1
71	*B.J.Mole 175*	MEL	Parlour Mtns NSW	12.80	1.57	1.09	0.00	22.40	5.75	6.00	7.80	7.00	2.07	0	0	1	1
72	*B.J.Mole 177*	MEL	Torrington NSW	24.30	3.67	1.40	4.40	21.80	5.00	8.80	6.90	6.70	2.59	1	0	1	1
73	*B.J.Mole 178*	MEL	Torrington NSW	23.90	3.05	1.38	3.40	21.20	5.80	9.90	10.40	6.50	1.90	1	0	1	1
74	*B.J.Mole 179*	MEL	Torrington NSW	25.70	3.38	1.18	3.90	20.40	5.50	10.60	7.50	6.30	2.35	1	0	1	1
75	*B.J.Mole 180*	MEL	Torrington NSW	19.60	2.67	1.19	2.20	16.60	4.86	11.50	7.60	6.20	2.32	1	0	1	1
76	*B.J.Mole 181*	MEL	Torrington NSW	24.60	2.58	1.29	2.90	16.60	5.00	14.30	8.00	6.30	1.87	1	0	1	1
77	*D.H.Ashton s.n.*	MELU *14864*	Wallaby creek Vic	21.00	2.73	1.82	3.70	3.00	4.00	6.50	5.90	5.20	2.01	1	0	1	1
78	*M.Gill s.n.*	MELU *19798*	Wallaby creek Vic	10.50	2.13	1.51	2.50	3.40	4.60	7.00	5.20	4.80	2.03	1	0	1	1
79	*M.Gill s.n.*	MELU *19802*	Wallaby creek Vic	13.20	2.75	1.75	3.20	4.20	5.00	6.60	4.60	5.40	2.20	1	0	1	1
80	*Anon*	MELU *19803*	Wallaby creek Vic	23.40	3.16	1.82	4.10	5.60	4.00	5.50	8.70	6.00	2.24	1	0	1	1
81	*F.Mueller s.n.*	MEL *708637*	Mt Dissapointment Vic	14.20	2.66	1.56	2.80	2.40	3.80	5.20	4.40	4.50	1.98	1	0	1	1
82	*F.Mueller s.n.*	MEL *708638*	Mt Dissapointment Vic	9.90	2.11	1.76	2.60	4.80	3.25	5.00	4.50	4.40	2.33	1	0	1	1
83	*F.Mueller s.n.*	MEL *708656*	Mt Dissapointment Vic	6.30	2.85	1.71	2.20	2.20	3.00	5.90	3.80	3.25	2.17	1	0	1	1
84	*G.Weindorfer 185*	MEL *5199*	Plenty Ranges Vic	22.00	3.06	2.19	3.20	1.80	4.80	5.80	10.50	5.10	2.55	1	0	1	1
85	*B.Hemphill s.n.*	MEL s.n.	Upper Ferntree Gully Vic	9.50	2.45	1.61	1.70	2.00	3.33	4.40	9.00	4.10	2.32	1	0	1	0.5
86	*J.H.Willis s.n.*	MEL *709148*	Belgrave Vic	8.40	1.76	1.54	1.90	1.20	3.60	4.90	8.70	4.30	2.43	1	0	1	0
87	*N.G.Walsh 3507*	MEL *2020508*	Emerald Vic	10.80	2.42	1.60	2.20	2.80	4.33	4.50	5.70	3.80	2.00	1	0	1	0.5

Specimen Number	*Collector & Number*	Herbarium & Sheet	Locality Number	CharacterNumber 1	2	3	4	5	6	7	8	9	10	11	12	13	14
88	*J.H.Willis s.n.*	MEL *502061*	Black Mtn Vic	16.60	2.45	1.66	1.80	13.00	5.67	8.30	10.60	5.50	2.05	1	0	1	1
89	*F.E.Davies 677*	CBG *8804043*	Pine Mtn Vic	21.10	3.44	1.49	1.60	10.20	3.00	6.33	5.40	7.00	2.32	1	0	1	1
90	*J.H.Willis s.n.*	MEL *709146*	Pine Mtn Vic	22.50	3.35	1.73	2.50	10.60	5.00	6.40	11.40	6.30	2.41	1	0	1	1
91	*N.G.Walsh 2126*	MEL *268504*	Upper Genoa River Vic	22.80	3.50	2.14	4.60	12.80	5.00	5.40	7.00	4.67	1.62	1	0	1	1
92	*D.E.Albrecht 3699*	MEL *268505*	Upper Genoa River Vic	25.70	2.68	1.57	6.30	6.40	5.00	5.90	999	6.60	2.34	1	0	1	1
93	*N.A.Wakefield 3261*	MEL *543047*	Upper Genoa River Vic	20.80	3.18	1.67	3.50	15.20	5.00	6.30	4.50	5.00	2.50	1	0	1	1
94	*N.A.Wakefield s.n.*	MEL *709 144*	Upper Genoa River Vic	24.00	3.80	1.66	3.30	11.40	5.67	7.20	6.60	3.80	2.00	1	0	1	1
95	*N.A.Wakefield 3201*	MEL *543046*	Upper Genoa River Vic	16.00	1.90	1.41	3.60	12.80	5.20	5.50	9.80	5.10	2.55	1	0	1	1
96	*M.E.Phillips s.n.*	NSW *262309*	Geehi NSW	19.80	2.31	2.13	4.10	13.20	4.25	999	999	999	999	1	999	999	999
97	*D.J. Wimbush s.n*	CANB *261158*	Geehi NSW	25.88	2.98	1.79	2.75	10.20	4.33	5.30	15.40	5.60	1.70	1	0	1	1
98	*N.Taws 235*	CBG *9314794*	Peak River NSW	27.90	4.12	1.73	1.80	1.40	5.75	5.20	13.00	8.10	2.47	1	0	1	1
99	*N.Taws 239*	CBG *9314798*	Peak River NSW	37.80	5.12	2.05	1.90	1.00	4.50	5.80	10.60	6.00	2.32	1	0	1	1
100	*M.E.Phillips 99*	CBG *005413*	Cabramurra NSW	18.70	2.78	1.85	1.70	28.60	3.00	5.10	14.30	5.60	2.36	1	0	1	1
101	*J.D.Lynch s.n.*	NSW *374566*	Deepwater NSW	18.00	2.65	1.19	3.40	23.60	4.86	4.60	6.60	5.00	2.17	1	0	1	1
102	*G.L.Davis s.n.*	NSW *374569*	Parlour Mtns NSW	12.90	2.19	1.11	0.00	31.00	4.00	5.50	999	999	999	0	0	1	1
103	*R.Coveny 8937*	NSW *468152*	Mt Kaputar NSW	17.30	2.67	1.19	0.00	22.00	5.67	5.00	9.20	6.00	2.02	1	0	1	1
104	*M.Kennedy 477*	NSW *262289*	Mt Kaputar NSW	15.50	1.74	1.20	0.00	26.00	4.33	4.80	999	6.13	2.35	1	0	1	1
105	*R.H.Cambage s.n.*	NSW *262327*	Mt Lindsay NSW	16.30	2.56	1.12	0.00	25.00	6.00	5.80	8.90	5.50	2.15	1	0	1	1
106	*E.F.Constable s.n.*	NSW *52954*	Mt Canobolas NSW	17.70	2.16	1.26	0.20	16.60	5.40	7.60	11.70	6.70	2.25	1	0	1	1
107	*W.E.Giles s.n.*	NSW *468148*	Mt Canobolas NSW	20.90	3.57	1.14	0.60	13.20	4.00	7.67	999	8.20	1.96	1	0	1	1
108	*W.E.Giles s.n.*	NSW *262271*	Mt Canobolas NSW	20.50	3.40	1.17	1.00	25.60	5.00	5.50	999	7.50	2.14	1	0	1	1
109	*W.F.Blakeley s.n.*	NSW *2214*	Penrose NSW	7.10	1.50	1.37	2.10	1.40	1.00	0.40	1.80	4.83	2.67	1	0	1	1
110	*W.F.Blakeley s.n.*	MEL *232746*	Penrose NSW	8.00	1.71	1.49	2.60	3.20	1.00	0.70	1.10	4.50	1.98	1	0	1	1
111	*W.J.Buckingham s.n*	NSW *468135*	Wingello NSW	8.00	1.60	1.50	2.10	1.00	1.00	1.40	1.00	5.40	2.42	1	0	1	1
112	*S.Donaldson 560*	CBG *951 3536*	Mittagong NSW	7.80	2.36	1.32	1.80	1.40	1.00	0.70	1.00	4.40	2.02	1	0	1	1
113	*M.Kennedy 153*	NSW *249646*	Medway NSW	10.70	1.68	1.77	3.50	7.80	1.00	0.00	1.80	6.30	2.17	1	0	1	1
114	*G.Errington 30*	NSW *264105*	Medway NSW	13.80	2.58	1.25	2.20	17.60	1.00	999	999	999	999	1	999	999	999
115	*A.Cunningham s.n.*	MEL *4546*	Blue Mtns NSW	13.80	1.87	1.42	3.00	0.00	1.00	0.00	1.00	6.00	3.00	1	1	0	1
116	*R.Cunningham s.n.*	KEW	Blue Mtns NSW	14.30	1.85	1.57	3.40	0.00	1.00	0.00	1.50	7.00	3.36	1	1	0	1